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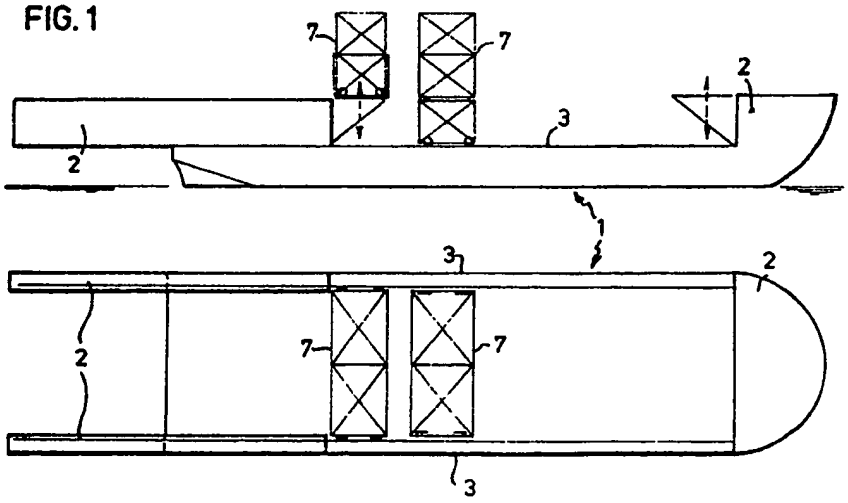
(54) A method of transporting, installing or removing a marine object, and a semi-submersible vessel for implementation of the method.

(57) A method and a device, particularly a semi-submersible or a dockship, for engaging a load at sea, with additional buoyancy being provided by three or more superstructures, particularly outriggers, which are adapted to function as buoyant isles when the load is engaged, for improved stability when at work, and at least a pair of outriggers functioning as fork lift tines engaging the load.

FIG. 1



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A METHOD OF TRANSPORTING, INSTALLING OR REMOVING A MARINE OBJECT, AND A SEMI-SUBMERSIBLE VESSEL FOR IMPLEMENTATION OF THE METHOD

This invention relates to a method of transporting, installing or removing a marine object by means of a buoyant body, the longitudinal sides of which operate at the sides of the object, and with a transverse structure extending from one transverse side between the longitudinal sides, and the opposed transverse side passing under the object.

There is such a method known, with at said opposed transverse side a bay being formed in the transverse structure so that the buoyant body has a U-shape, but this transverse structure interrupted by a bay has the drawback that the buoyant body tends to trim aft and must be trimmed level in its starting position already.

It is intended to obviate this drawback by a novel method wherein the transverse structure is uninterrupted, and buoyancy possessing outriggers as tail ends at the upside substantially in the extension of the longitudinal sides of the buoyant body get into the water under the object. In its starting position the buoyant body lies trimmed level and under the object the outriggers lend thereto an at an increasing rate rearward displacement so that the buoyant body also under the load remains lying trimmed substantially level.

It concerns here a semi-submersible vessel, characterized by three or more superstructures, particularly fore a buoyancy possessing bridge house and aft the outriggers which under the load carried thereby get into the water. Therewith these superstructures have a sufficiently small waterline area to reduce motions and loads as a result of waves.

During the transport of the marine object the loading deck of the vessel is sufficiently above water so that the loading deck is free of the wave action.

At the destined loading or unloading site the vessel is then ballasted and semi-submerged to the extent that the deck under a heavy load would almost entirely disappear underwater. Only the three superstructures still extend above water. The two superstructures comprising the outriggers, embodied as tail ends, which extend over the rear or also the side of the vessel, lend thereto, when submerging, at an in creasing rate carrying capacity rearwardly of the stern.

In order to compensate the load on the outriggers, the outriggers can be provided with additional buoyant bodies which can be added at the site.

These buoyant bodies which compensate the load may be open from below so that they are to be trimmed with air pressure.

The outriggers can be used in two manners for installation purposes:

A) in combination with one or more gantry cranes,

B) the direct use of the outriggers to lift objects according to the fork lift principle.

A) The combination of outriggers with gantry cranes

The combination of outriggers and gantry cranes can in principle be used for the installation at sea of submarine systems and submarine objects, or of objects and systems above water.

For submarine objects rather low gantry cranes would suffice, for installation of objects above water higher gantry cranes are required.

The gantry cranes are preferably provided with a hydraulic lifting device which will be described later on.

The gantry cranes can, however, also be provided with a slide or roll system so that they can place an object from the vessel outboard or reversely inboard.

The lifting device on the gantry cranes can be a hydraulic device which clamps a plurality of wires. The use of such a system to lift loads offshore is an important aspect of the present invention.

The hydraulic lifting device is provided with two clamping systems which are attached to a hollow cylinder.

The movable part (the piston) is provided with a clamping system and the fixed portion is provided with a clamping system. By alternately using the two clamping devices the wires can be hauled through the jack or be payed out.

Especially the use at sea of this type of wire jack is an important aspect. Therewith, in one embodiment, this jack can also be mounted on a second hydraulic cylinder, whereby the roll and pitch motions of the ship are isolated from the load.

With the pilot line the compensation motion can be controlled.

Moreover, the unit can be connected to an air system for compensation of the vertical motions of the installation vessel.

B) The fork lift principle or directly lifting with the outriggers

Loads can offshore also directly be lifted by means of the outriggers.

As an example the top structure of a drilling platform is here described. Herewith the heavy load to be transported, particularly said top structure of a drilling platfrom, is lifted off the lower structure of the drilling platform according to the fork lift principle and loaded on the outriggers of a vessel, particularly the tail ends which are situated in the extension of the twin boards of a dockship, for the transport, and lifted off the outriggers to be installed on said lower structure, respectively.

Therewith the problem arises that the load each time should be positioned correctly with respect to the outriggers, and notably the top structure of a drilling platform, to be transported or to be installed, should be very accurately relatively adjusted between the outriggers of the vessel and the lower structure of the drilling platform.

This problem is solved effectively with the method according to the present invention by accurately positioning the outriggers under the load while utilizing carrier supports, and the preferred embodiment of an arrangement for performing this method is characterized by carrier supports upholding the load on each side, and furthermore by a support beam structure to be arranged on the outriggers under the load, with a position which is adjustable by means of carrier pads, with the carrier pad pressure being fluid-controlled. When the carrier pad pressure is sufficient the load will rest in a somewhat floating manner on the carrier pads so that a relative adjustment with respect to the outriggers which carry the load can be effected and, when the correct adjustment is reached, by reducing the carrier pad pressure a fixation of the adjustment can be obtained.

When lifting or lowering the top structure of a drilling platform on its lower structure, by slidingly shifting the supporting beams a finer adjustment of the top structure with respect to the lower structure is now obtained.

Moreover, the cyclic motions as a result of the swell are compensated.

Therewith is taken care that the relative shifting of the load with respect to the outriggers is steered in the right manner due to the fact that the carrier pads are adjustable in longitudinal alignments on the outriggers, said longitudinal alignments extending onto the gangways of the ship so that the carrier pads with the load carried thereby are displaceable between positions outboard and inboard, and furthermore also by alignments located under the transverse beams of the support beam structure, for self-adjustment of the carrier pads transversely. In this manner a universal adjustability of the load with respect to the outriggers is obtained.

This shifting of the supporting beams with respect to the outriggers can be effected:

- in that the supporting beams are actively controlled by hydraulic cylinders which control the supporting beams at the rate of the measured motions of the outriggers;
- by cross-wires which are passed from winches aboard the ship to the lower structure of the drilling platform and are secured thereon and/or
- by a homing system between the respective drilling platform legs as will be further described in the following.

Also a combination of the above mentioned systems is possible.

The choice which system is applicable will depend on the maximum allowable loads on the lower structure and the sea condition to be expected during the installation or removel.

The invention will be further described in the following in view of illustrative embodiments thereof as represented in the attendant drawings, which should, however, not be interpreted in a restrictive sense as of course other embodiments are feasible within its scope.

Figures 1, 2 and 3 represent embodiments of a barge with superstructures for installing or dismounting objects at sea under or above water.

Figure 2 shows possibilities for the connection of the three super structures with working deck and accommodation above water.

Figure 3 shows an example with continuous dock walls.

Figure 4 depicts the use of outriggers and gantry cranes in a semi-submersible vessel.

Figure 5 gives possibilities of adding additional buoyancy to reduce the moments on the outriggers and is a schematice general perspective view of a semi-submersible vessel, such as a dockship, which as illustrated is engaged in loading the top structure of a drilling rig or is lifting off this top structure from its outriggers to install it on the lower structure, the so-called jacket, of the drilling rig.

Figure 6 gives an example of a low gantry crane for operations under water.

Figure 7 gives an example of a high gantry crane for the operation above water.

Figure 8 shows the high gantry cranes which place an object underwater.

Figure 9 depicts a wire-jack which is to be used on a gantry crane in operations offshore.

Figure 10 shows the the wire-jack mounted on a hydraulic cylinder for roll, pitch and vertical compensation.

Figure 11 is a schematic representation of a carrier pad system which is arranged on the outriggers under the load to make its correct positioning possible.

Figure 12 illustrates the compensation of notably the outrigger motions due to the swell, by means of a hydraulic jack.

Figure 13A and 13B show in longitudinal view and in rear view resilient cross-wires by which the water motion can be compensated.

Figure 14 shows the homing of top structure legs on the jacket structure.

Figure 15A shows supported on the boards of a dockship the top structure of a drilling platform, which is made ready for the transport, in end view as seen from the stern, and figure 15B is a corresponding lateral view of the ship aft.

The semi-submersible vessel 1 as represented in the drawings is shown in longitudinal and in plan view in figure 1 and is provided with with additional buoyant bodies 2 in the form of a watertight bridge house fore and, embodied as tail ends, outriggers in substantially the extension of the board walls 3 of the loading deck of the vessel 1, which is situated rearwardly of the bridge house.

As an example it is stated that the vessel 1 has a length of 180 m, a beam of 40 m and a depth of about 9 m, that the bridge house has a length of 20 m and the outriggers a length of 70 m, and that said buoyant bodies 2 extend to a heigth of 20 m above the base line of the vessel.

In figure 2 the transport draft t and the installation draft t' at sea of the vessel 1 are indicated. The load 4 depends here, as shown, from a working platform.

In figure 3a semi-submersible vessel or so-called "semi-submersible" 1 is represented, which is provided with fixed carrier legs 26 in the form of hollow columns, which hollow columns 26 extend through the water surface 29 and are connected at the bottom side, on each side of the vessel 1, by caisson floats 30, and between which the necessary supports in the form of braces and rungs such as 31 are arranged. On said carrier legs 26 rests a superstructure of which in figure 3 only the working deck 32 is schematically represented. Also this semi-submersible vessel 1 is provided with outriggers 2 by which a heavy load which here in this figure is not further represented, is to be controlled.

In figures 4 and 5 a semi-submersible vessel 1 consisting of a dockship is represented, which has outriggers 2 in the form af tail ends projecting in the extension of the twin boards 3, by which according to the fork lift principle a heavy load 4 which may consist of the top structure of a drilling rig, can be lifted off the jacket, indicated at 5, of the drilling rig, or from which the load 4 can be lifted to be installed on the jacket 5.

It is noted that the dockship 1 as represented in figures 4 and 5 has a large unobstructed hold 6 defined between said twin boards 3, which is to be closed by means of hatch covers, not represented in these figures, and which, for loading and unloading dry cargo through the hatch opening, is to be served by a gantry crane, generally indicated at 7, which rides on the gangways 8 on the twin boards 3, whereas in this ship 1 wet cargo may be stowed in the hold 6 through the stern 9 which is to be opened to that effect, and to that end the ship 1 will then be semi-submerged.

The heavy load, illustrated in figure 5, which as represented may consist of said top structure 4 of a drilling platform, is stowed on the outriggers 2 on a support beam structure to be placed under the load 4, comprising a plurality of supporting beams 10, with the interpositioning of fluid pads 11 which are indicated with dotted lines in figure 5 and are shown in more detail in figure 11. With a sufficient fluid pressure in the carrier pads 11 the load 4 will then arrive at a supporting condition which may be regarded as somewhat "floating" in order to, by slidingly shifting on the carrier pads 2 on the outriggers 2, thus be accurately located in a desired position, and upon locating it in the desired position, the fluid pressure may then be lowered and a fixed position be obtained.

This concerns lifting and removing the load 4 for its transport. When installing the topside 4 the operation is reversed, with some further provisions being made to position it on the jacket 5 as will be further described here in the following.

Positioning the vessel 1 with respect to the load 4 is in all cases in first instance being effected by trimming the vessel 1 with ballast.

For a universal displaceability of the load 4 with respect to the vessel 1 said carrier pads 11 are adapted to be slidingly shifted in longitudinal alignments 12 on the outriggers 2, which extend onto the gangways 8 so that the carrier pads 11 with the load 4 resting thereon can be slidingly displaced in longitudinal directions between positions outboard and inboard, and the carrier pads 11 can also be shiftable in a gliding or as said somewhat "floating" manner in transverse alignments 13 which are arranged under the support beams 10.

A carrier pad in the form of a flat jack pad, provided with a top layer of low friction, can also be constructed so large that a slide beam can freely move along it in longitudinal and transverse directions.

As carrier supports also so-called air or water skates can be used, which are not further represented.

The carrier pads 11 as illustrated in figure 11 are adapted to be fluid-pressurized by way of the hydraulic supply line indicated at 14, and are covered by a steel sheet 15, or a composite sandwich of steel and rubber, with thereon a glide lining of teflon 16 on which the support beams 10 will rest. Accordingly, the carrier pads 11 as represented in figure 11 are themselves not displaceable as in the here earlier described embodiment but occupy a fixed place while the load 4 may slide thereon for

adjustment on the outriggers 2. To that end a slide shoe 17 of stainless steel can be placed under the load 4.

As a typical example, a slide pad 11 consisting of a fluid skate can have a carrying capacity per area dimension of 1 m^2 of more than 100 tons. A flat jack pad with teflon may carry a still many times higher load.

For shifting on or along the carrier or slide pads 11 the hydraulic jacks 18 as represented in figure 12 may be utilized, which are disposed between the ship structure and the supporting beams 10, and which are also adapted for compensation of the outrigger motion as a result of the water motion such as the swell.

Figures 13A and 13B depict in longitudinal view and in rear view the transfer of a heavy load 4 in the form of the illustrated topside of a drilling rig between the outriggers 2 and the jacket 5 of the drilling rig.

As shown, to that end cross-wires are passed from drums of winches 20 which are arranged aboard the ship 1, to their attachments on the legs 21 of the jack 5, said cross-wires 19 running on guide rollers 22 and comprising resilient means 23 for compensation of the water motion which is discernable aboard the ship 1.

When the correct adjustment is obtained, the legs 24 of the topside 4 of the drilling rig can be accurately threaded in the legs 24 of the jack 5 by means of a homing trunnion, and herewith the installation of the topside 4 of the drilling rig, which is transported by the ship 1, is then completed.

In figure 5 are furthermore shown carrier supports in the form of support legs 26 which are to be girded-on at the location of the outriggers 2 on each side of the ship 1, and are in the form of hollow columns which are to be trimmed by air pressure. The adjustment of the outriggers 2 under the load 4 can then be assisted by the regulation of valves, not shown, which are disposed in a control box 27, and regulate the air supply and discharge. To facilitate a proper girding-on of the support legs 26 onto the ship 1 a transverse beam connection 28 is provided therebetween at the location of the stern of the ship 1. Also at the location of the extended rear end of the outrigger tails 2 such a support or trim leg 26 can be provided, which is, however, not shown in figure 5 but which is to be connected with the two illustrated support legs 26 by a cross-structure of rungs.

Such carrier supports can also be provided for handling the jacket 5 of a drilling rig.

Figure 6 depicts a low gantry crane 7 by which submerged objects can be handled.

In view of figures 7-10 the lowering of a submerged system by means of a novel gripper system 33 will be described in the following:

An especially developed gripper system 33 will be applied for lowering below the sea level.

This gripper system 33 comprises a movable upper gripper 34 under the main hooks 35 of the ship 1 and a fixed lower gripper 36 which is arranged on an upper landing platform 37 and depends under the trolleys 38 of the ship' crane 7.

On the tackles 39 depends a lower landing platfrom 40 from which as shown the jacket 5 of a drilling rig is depending.

The gripper system 33 is designed on a safety factor of the work load of 2.5.

No substantial twisting of the manifold 2 is possible when using this system (vide figure 7). Moreover, the hanger wires 39, as shown in figure 8, may be tensioned by transverse or cross-wise extended coupling wires 41 to obviate any substantial torsion risk.

Figures 9 and 10 show the principle of the roll and pitch compensation. At 42 the swell compensation cylinder and at 43 the lifting cylinder is indicated and at 44 the pilot line. The clamps for alternately clamping and releasing the tackle wires 39 are indicated at 45.

A more detailed description of the lifting method follows herebelow in view of figures 14 and 15.

1. Brackets 46 are welded or clamped to the legs 47 of the jacket 5 at a suitable level (vide figure 14).

The load is introduced via the diaphragm plates 48 and thus the brackets 46 are only subjected at a very low rate to bending and mainly shear.

2. Supports 49 are welded over the cutting splice 50.

The legs 47 are cut at the cutting level 50 before the actual lifting (vide figure 15A).

3. Support beams 51 are brought into position by means of the outriggers 2 of the ship 1 and connected to the drilling platform by rack clamps or slings 52 (vide figure 15B).

4. The ship 1 is finally positioned by means of dynamic positioning and/or cross mooring wires to the jacket 5.

5. When it is in position, the ship 1 is ballasted and 80% of the weigth of the topsides 4 is taken by ballasting.

6. Tracks with teflon are provided to compensate the horizontal motions of the ship 1.

7. Then the ship cranes 7 are moved forward on their wheels and the topsides 4 are lifted free from the jacket 5 in approximate half a minute in order to prevent hammering between the jacket 5 and the topsides 4.

8. The support beams are shimmed on the tracks so that further movement is no longer possi-

ble.

9. The ship 1 sails with the topsides 4 to a sheltered area where the topsides 4 are transferred to a barge or a quay.

Claims

1. A method of transporting, installing or removing a marine object by means of a buoyant body, the longitudinal sides of which operate at the sides of the object, and with a transverse structure extending from one transverse side between the longitudinal sides, and the opposed transverse side passing under the object, **characterized** in that the transverse structure is uninterrupted, and buoyancy possessing outriggers as tail ends at the upside substantially in the extension of the longitudinal sides of the buoyant body get into the water under the object.

2. A device for implementation of the method according to claim 1 **characterized** in that the buoyant body consists of a semi-submersible vessel, of which the supersturctures have a sufficiently small waterline surface to reduce motions and loads as a result of waves, and with two of said superstructures being embodied as outriggers.

3. A device according to claim 2, **characterized** by three or more superstructures, particularly a buoyancy possessing bridge house fore and the outriggers which get into the water under the load carried thereby, aft.

4. A device according to claim 2 or 3, **characterized** in that on the outriggers operate one or more gantry cranes, or that the outriggers are directly used for lifting loads according to the fork lift principle.

5. A device according to claim 2, 3, or 4, **characterized** in that the outrigger superstructures extend along the entire length of the vessel, such as in a dockship, or along a short portion, depending on the required waterline area for sufficient stability and the reach of the gantry cranes, whereby the outriggers can be removable so that depending on the objects to be installed the waterline area can be varied, and whereby the outriggers can also extend partially in the transverse direction of the vessel.

6. A device according to any of claims 2-5, **characterized** in that additional buoyancy can be added to compensate the moments on the outriggers when lifting, if this is necessary for the strength of the out riggers or the stability.

7. A device according to claim 6, **characterized** in that the buoyancy which can compensate the load, is provided by buoyant bodies which are open at the bottom and can thus be trimmed with air.

8. A device according according to any of claims 2-7, **characterized** in that the gantry cranes can be provided with hydraulic lifting devices with a gripper system, whereby the lifting installation can be combined with motion compensation for the roll, pitch and vertical motions.

9. A device according to any of claims 2-8, **characterized** by a provision to arrange the load (4) directly on the outriggers (2) by menas of particularly a support beam structure (10).

10. A device according to any of claims 2-9, **characterized** in that the horizontal and vertical motions of the outriggers are to be compensated by means of carrier pads (11) with a low friction resistance.

11. A device according to claim 10, **characterized** in that the carrier pads (11) are adjustable in longitudinal alignments (12) on the outriggers (2) and in that the longitudinal alignments extend onto the gangways (8) of the ship (1) so that the carrier pads with the load (4) carried thereby are displaceable between positions outboard and inboard.

12. A device according to any of claims 9-11, **characterized** in that the supporting beams (10) are actively controlled by hydraulic cylinders (14) which control the supporting beams in view of the measured motions of the outriggers (2).

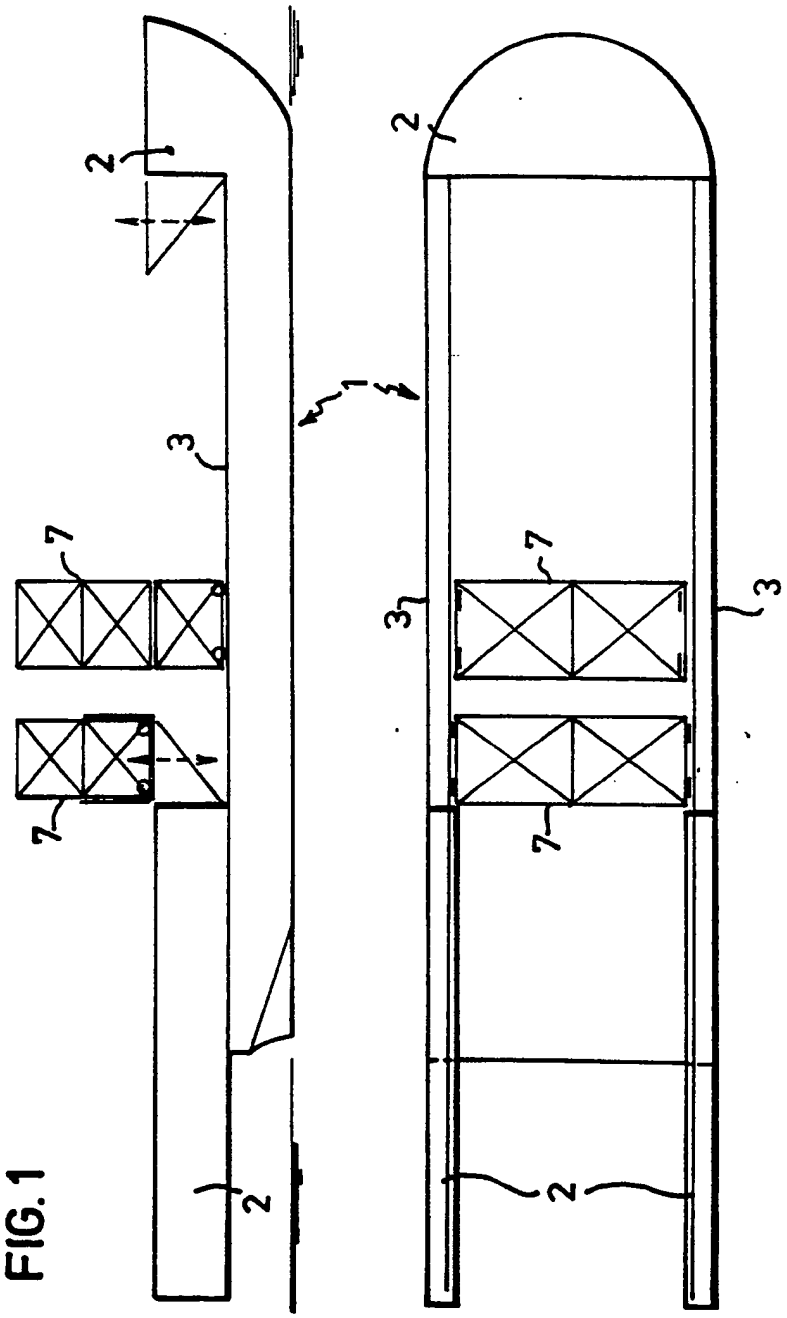


FIG. 1

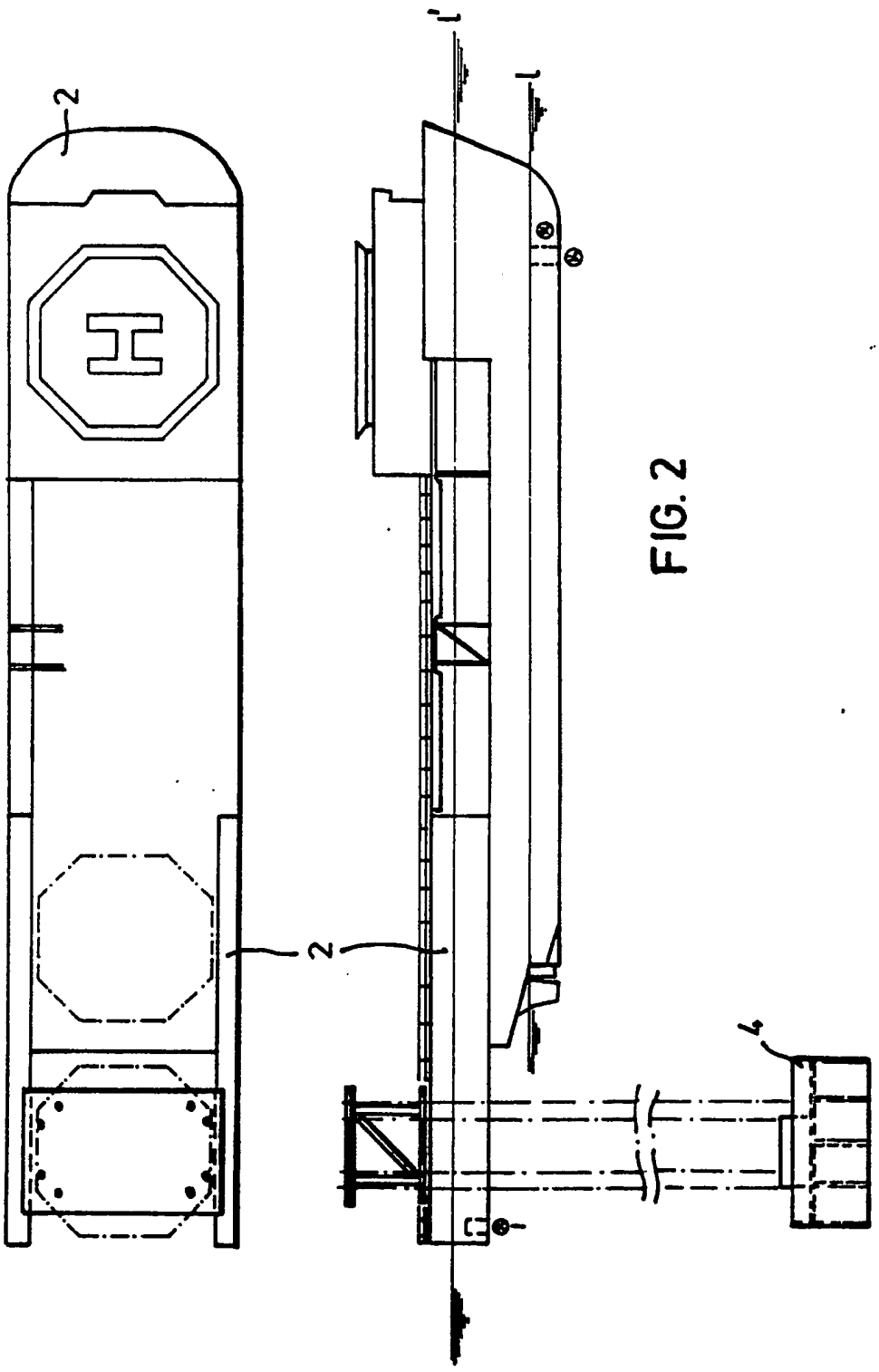


FIG. 2

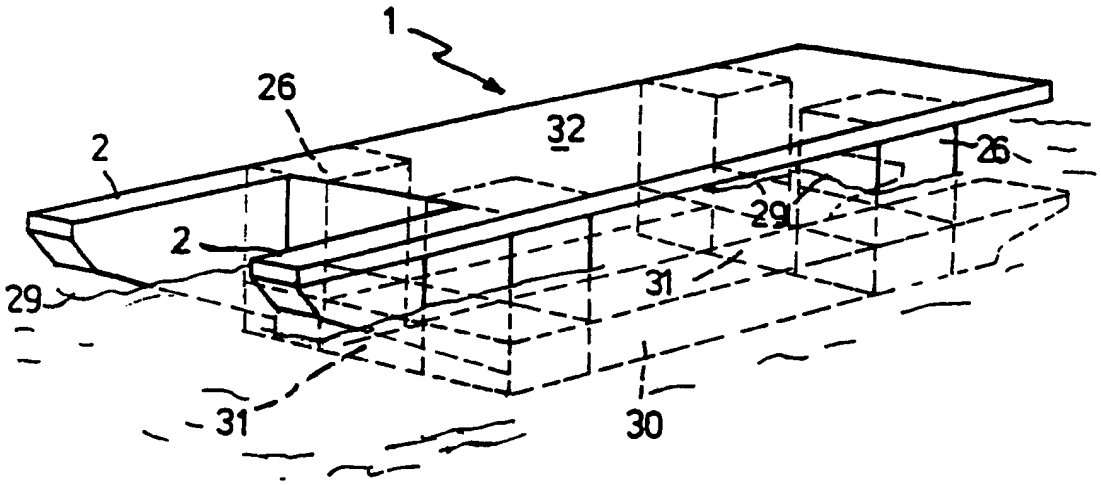


FIG. 3

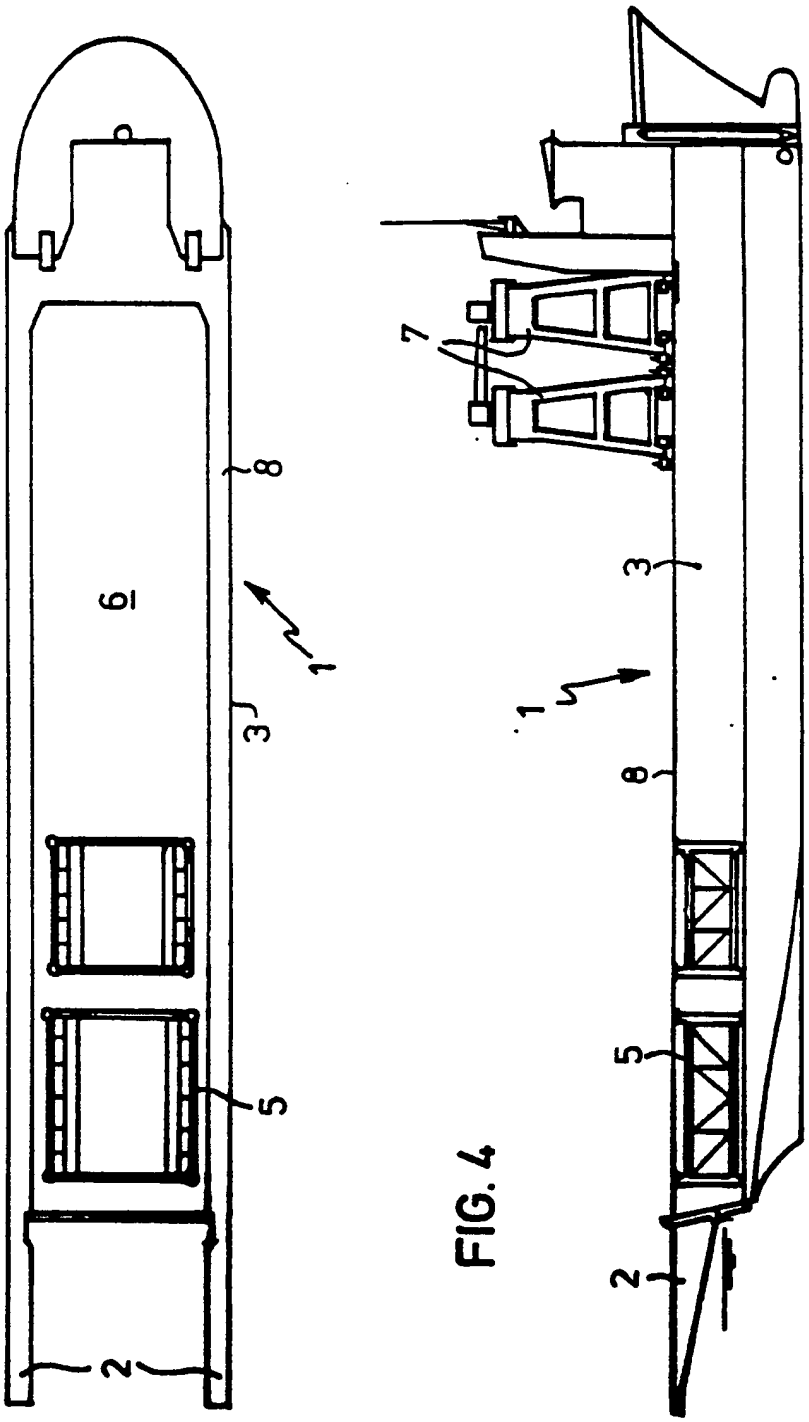


FIG. 4

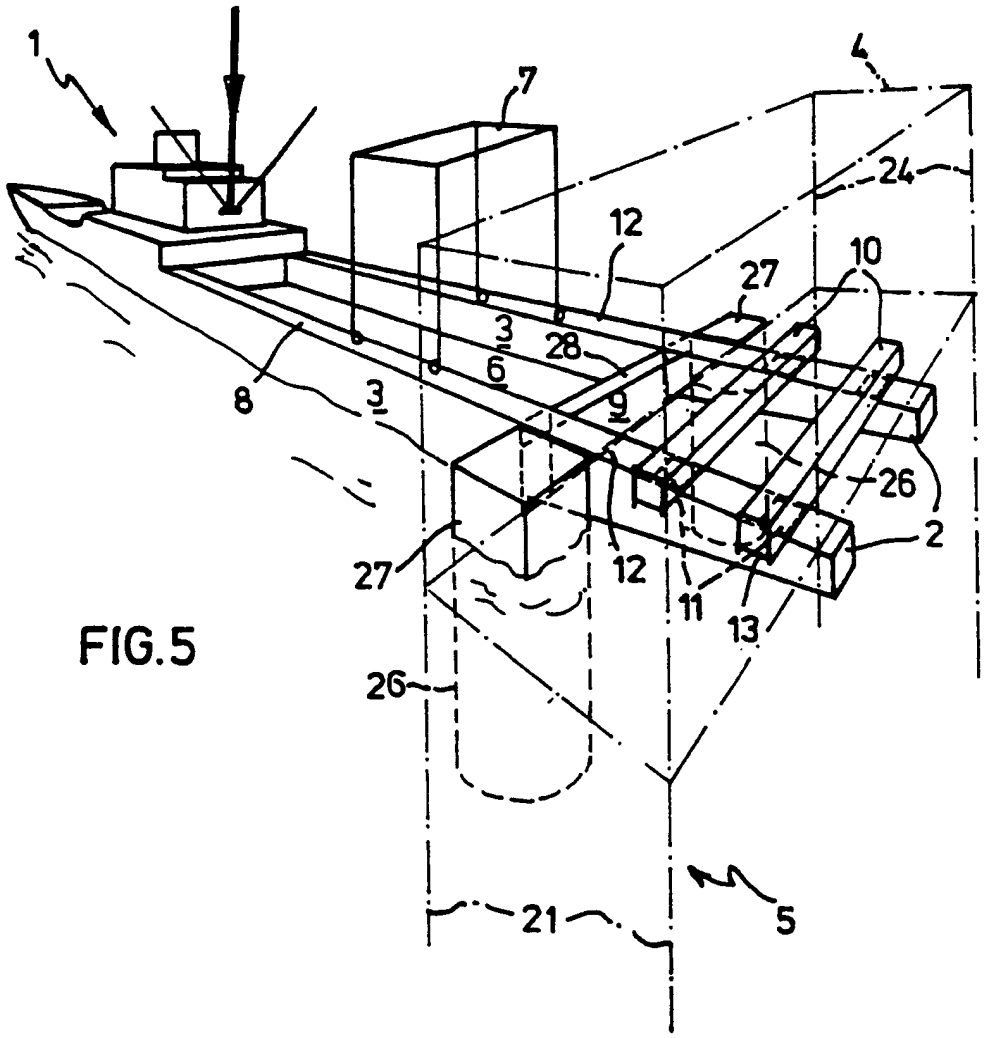
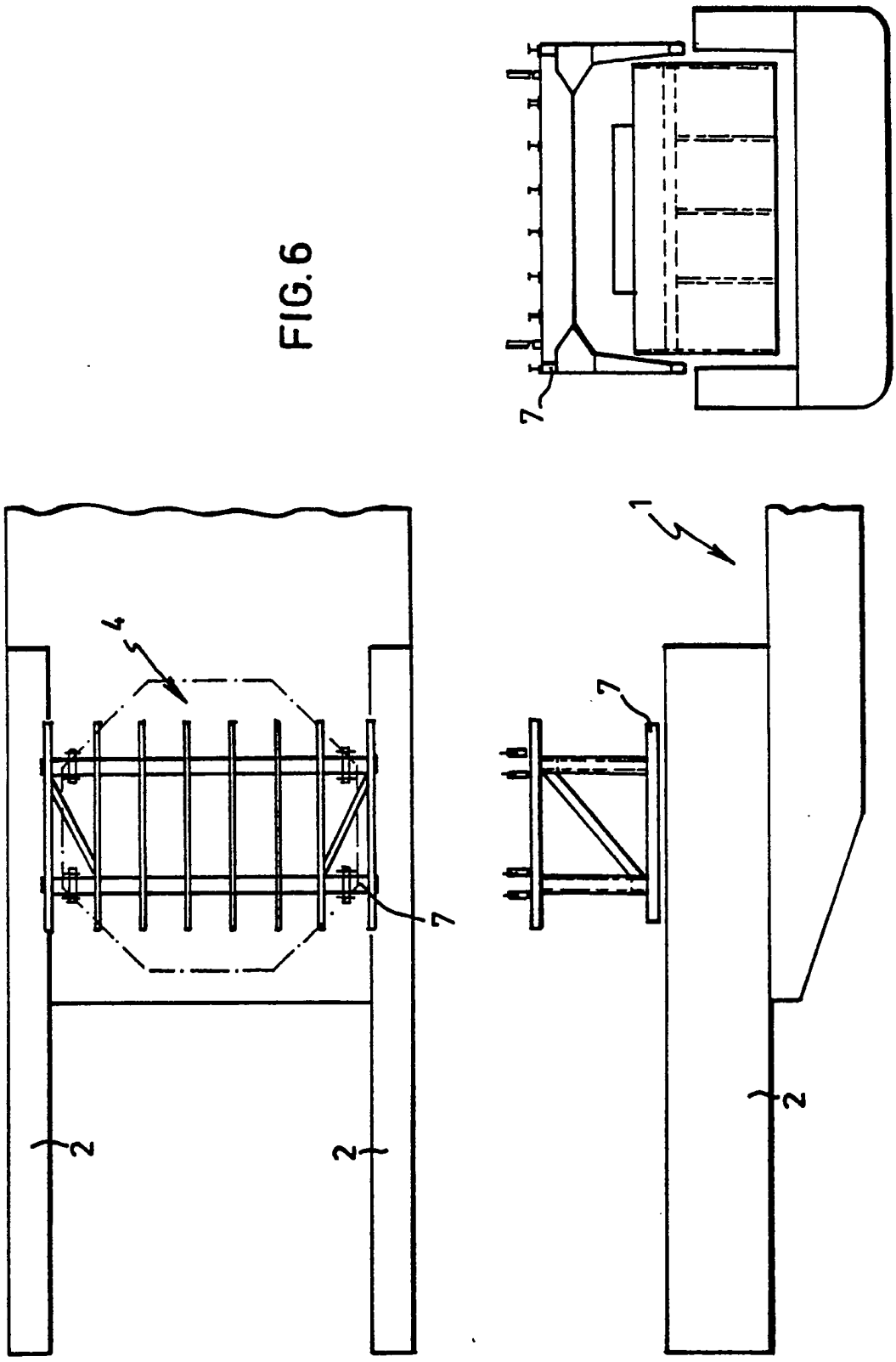


FIG.5

FIG.6



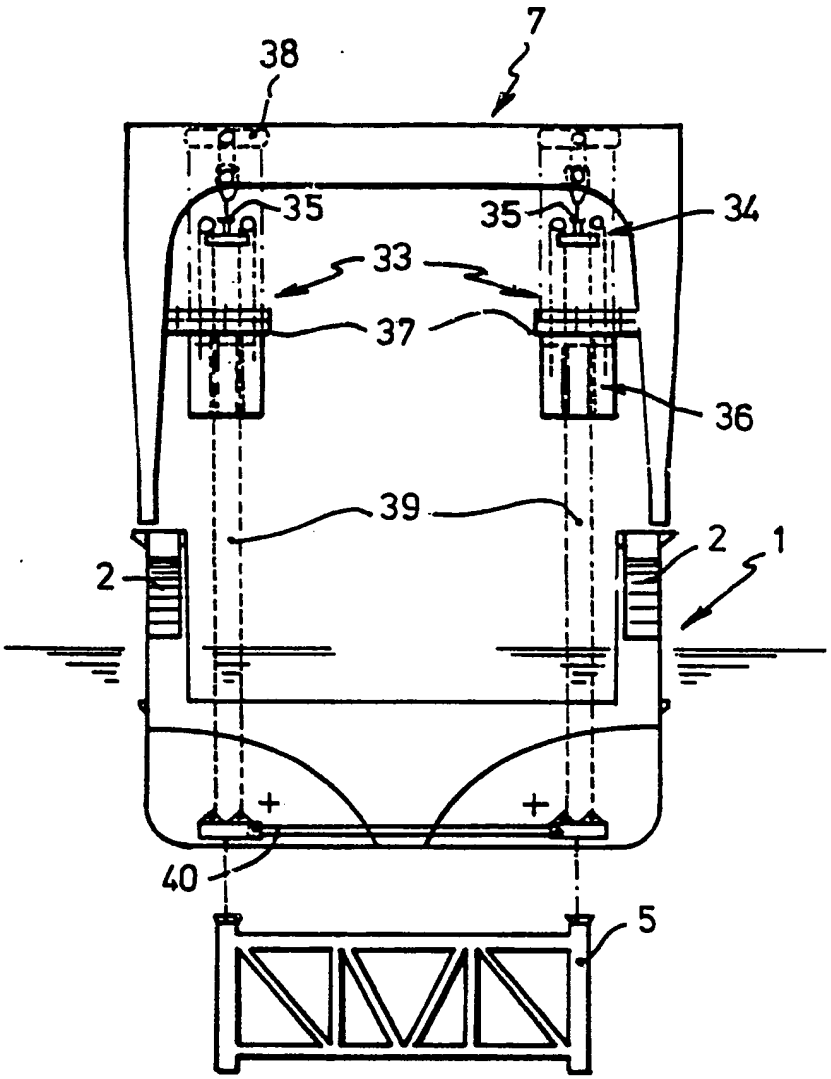


FIG.7

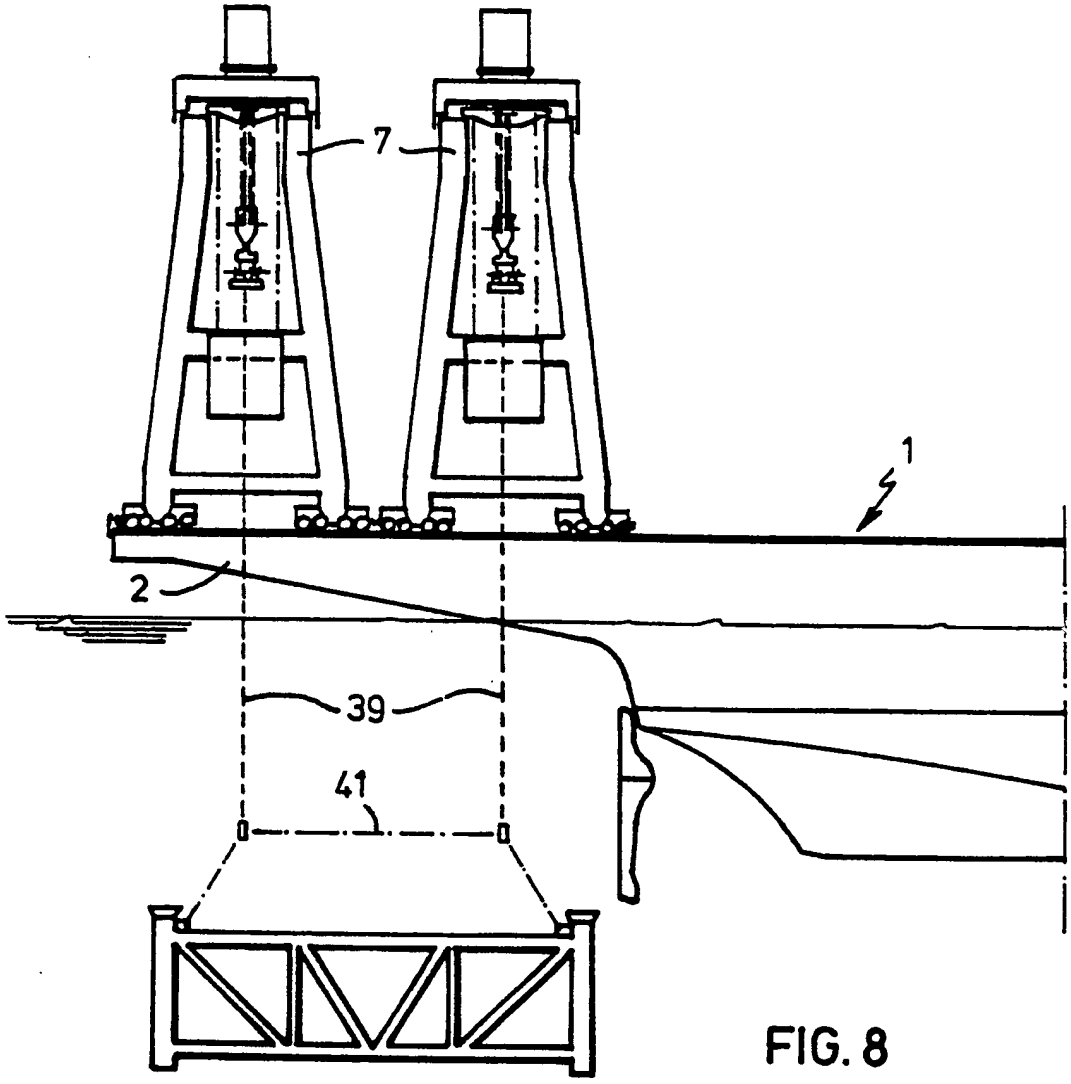


FIG. 8

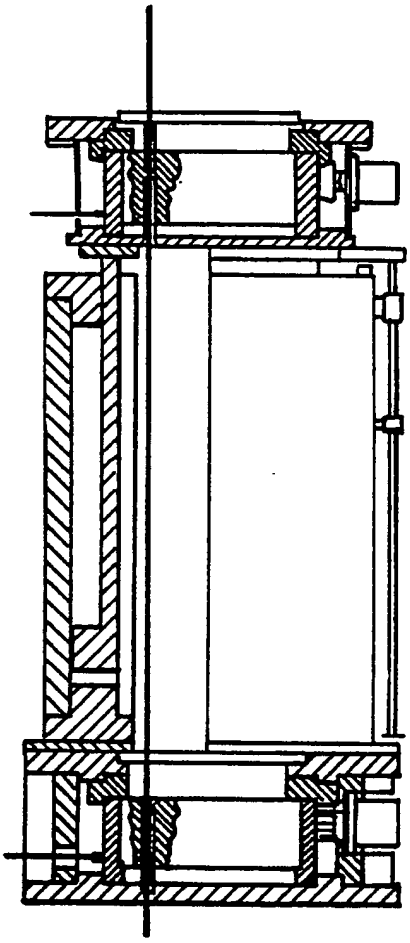
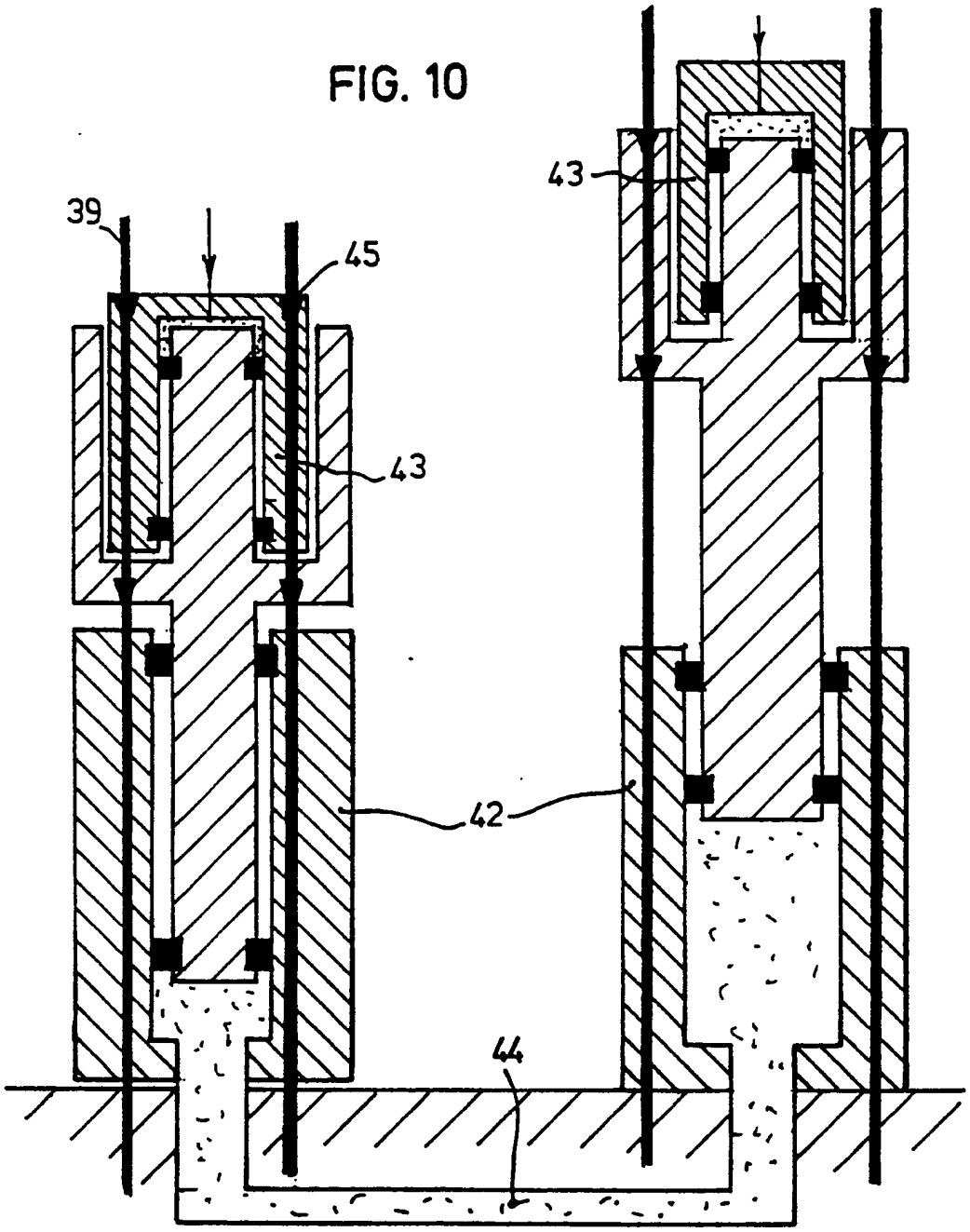


FIG. 9

FIG. 10



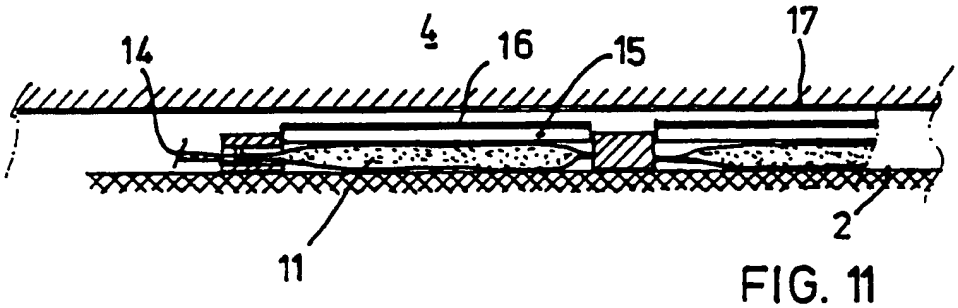


FIG. 11

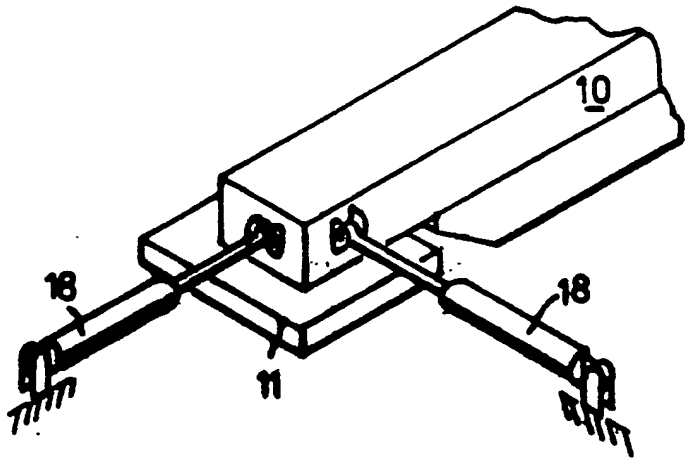


FIG. 12

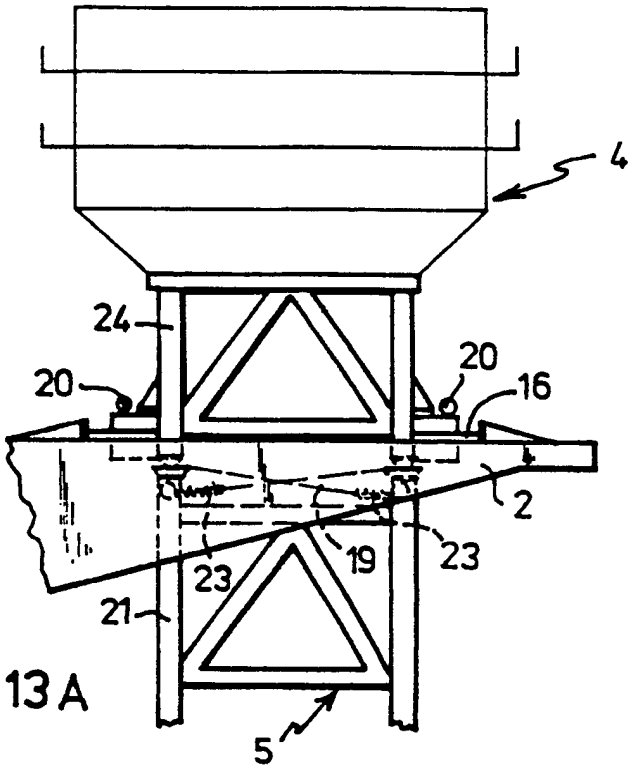


FIG. 13A

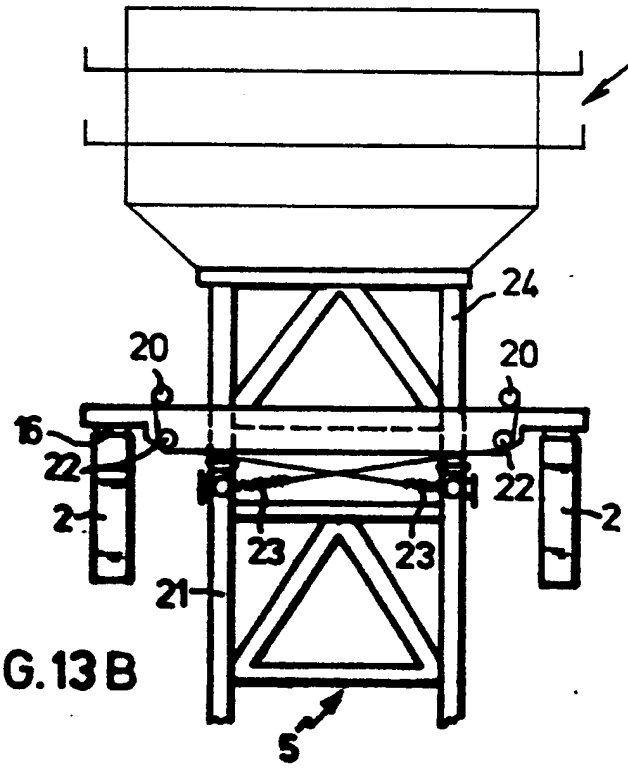


FIG. 13B

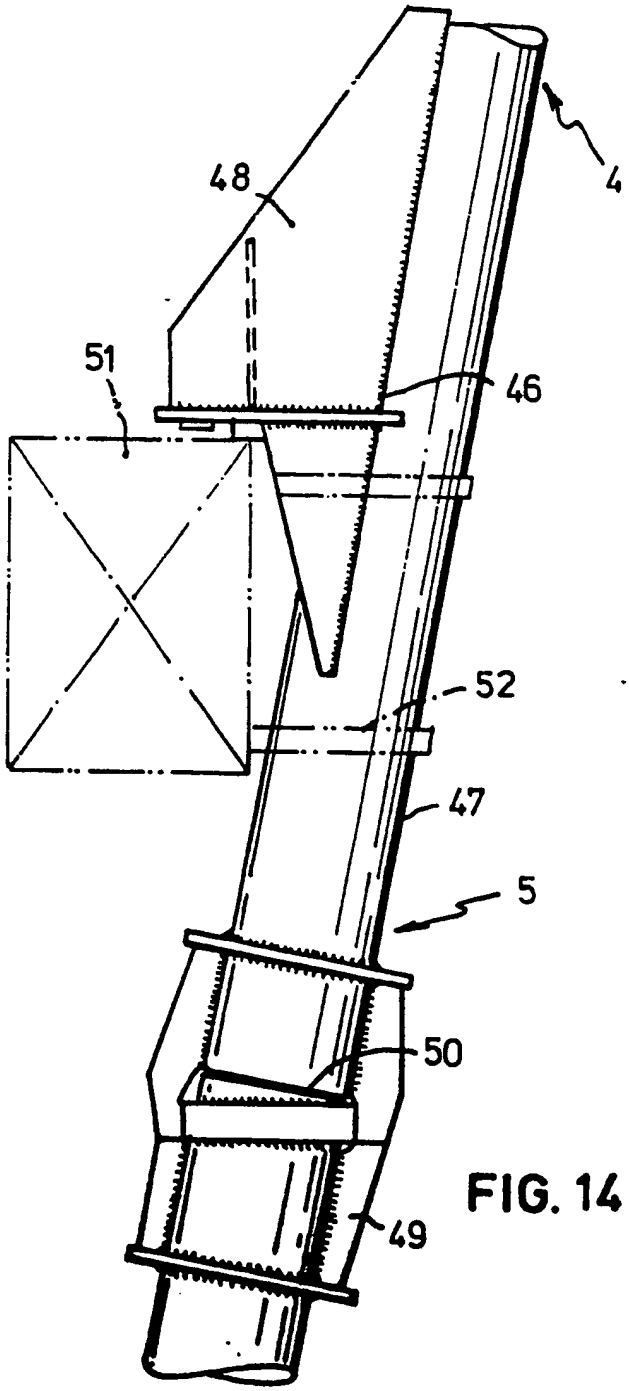


FIG. 14

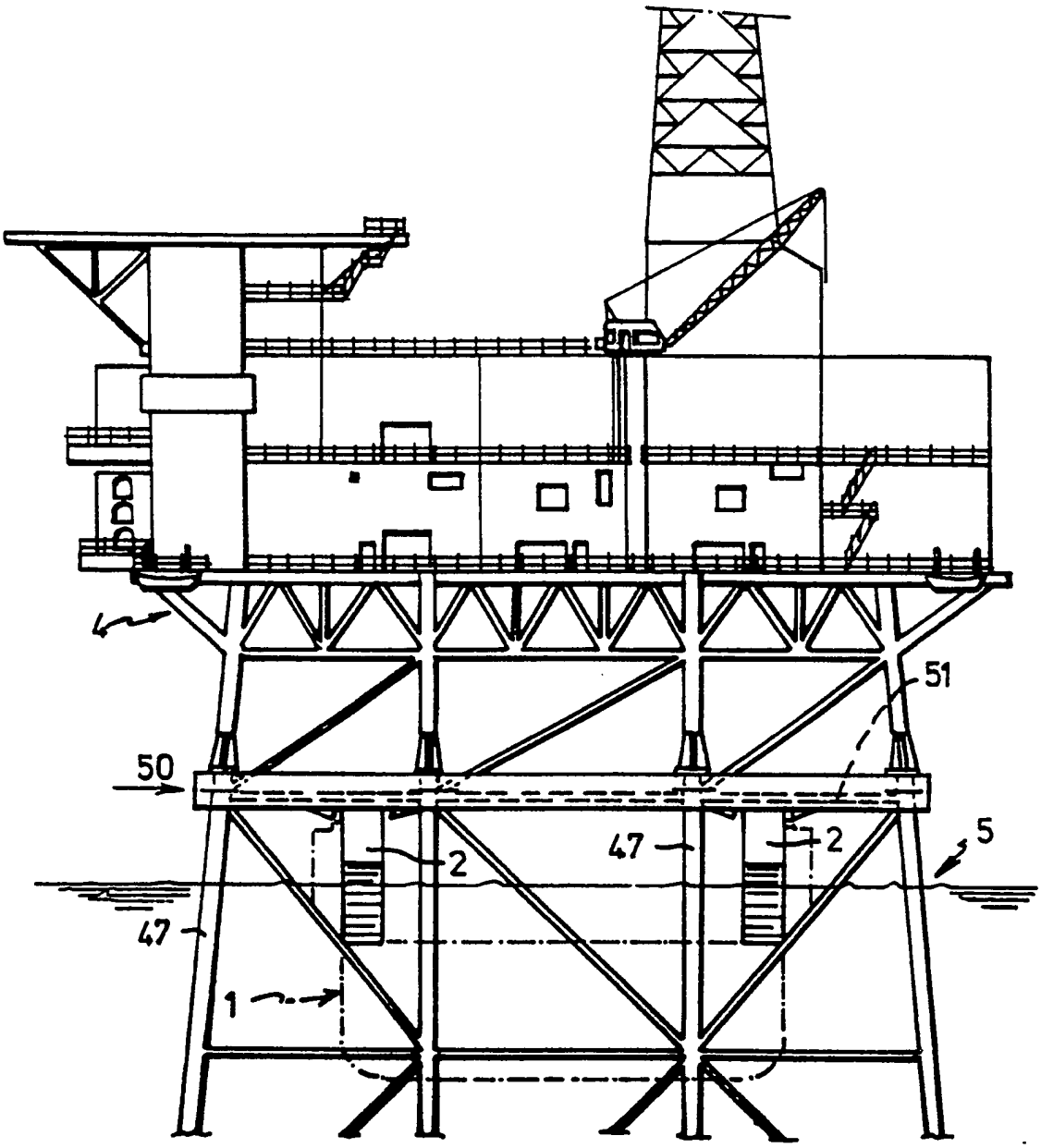


FIG.15A

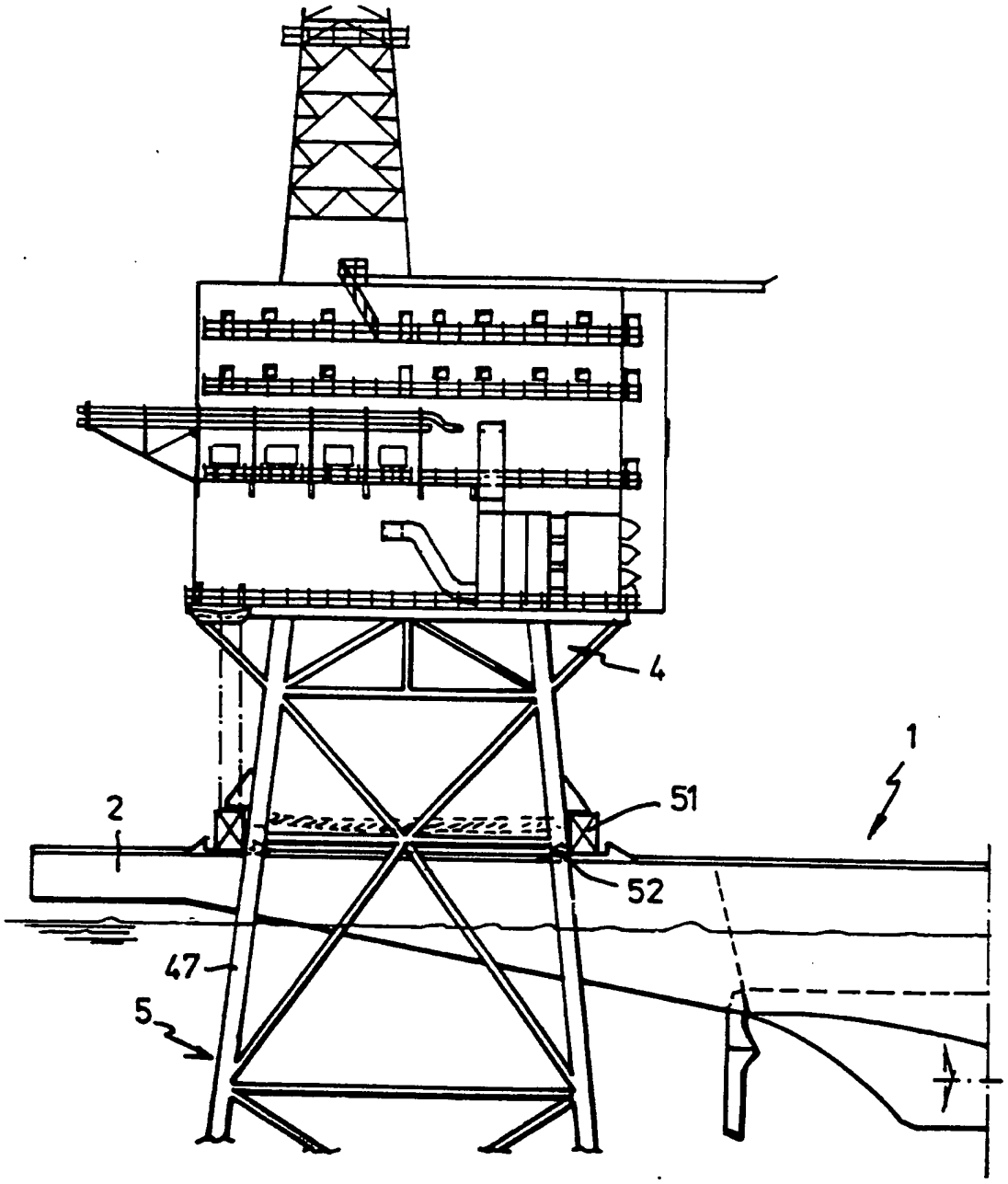


FIG. 15 B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 20 2012

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	GB-A-2 186 527 (BROAD) * Abstract; figure 1 *	1-5,9	B 63 B 35/00
A	GB-A-2 165 188 (HEEREMA) * Whole document *	9-12	
A	DE-A-2 812 568 (CON BRIO) * Whole document *	4,6,7	
A	FR-A-2 405 182 (COMPAGNIE FRANCAISE D'ENTREPRISES METALLIQUES)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03-09-1989	DE SCHEPPER H.P.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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